470A

SHOP
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HICKOK

LEADER IN DEPENDABILITY SINCE 1910

INSTRUCTION MANUAL

for

MODEL 470A
"UNISCALE"
VACUUM TUBE VOLT METER

HICKOK ELECTRICAL INSTRUMENT COMPANY • 10514 DUPONT AVENUE • CLEVELAND 8, OHIO

HICKOK

MODEL 470A
"UNISCALE"
VACUUM TUBE VOLT METER

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10514 DUPONT AVENUE · CLEVELAND 8, OHIO

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WESTERN UNION – KJ

1/63

2490-412

STANDARD EIA GUARANTEE

The Hickok Electrical Instrument Company warrants instruments manufactured by it to be free from defective material or factory workmanship and agrees to repair such instruments which, under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any instrument or test equipment which proves to be defective, when returned to us transportation prepaid, within 90 days from the date of original purchase, and provided the serial number has been made known to us promptly for our records.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons or service stations in any way so as, in our judgment to injure their stability or reliability, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither does this warranty apply to any of our products which have been connected, installed, or adjusted otherwise than in accordance with the instructions furnished by us. Accessories, including all vacuum tubes not of our manufacture used with this product are not covered by this warranty.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any other liability in connection with the sale of our products.

Parts will be made available for a minimum period of five years after the manufacture of this equipment has been discontinued. Parts include all materials, charts, instructions, diagrams, accessories, etc., which have been furnished in the standard model.

REGISTRATION CARD

The above guarantee is contingent upon the attached registration card being returned to the factory immediately upon receipt of the equipment.

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
Cleveland, Ohio

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, under warranty or otherwise, the factory must first be contacted giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly to the Hickok factory address, 10636 Leuer Avenue, Cleveland, Ohio, or to a designated service station in your locality. All correspondence pertaining to repairs should be directed to the Hickok office address, 10514 Dupont Avenue, Cleveland 8, Ohio, or to the authorized service station designated.

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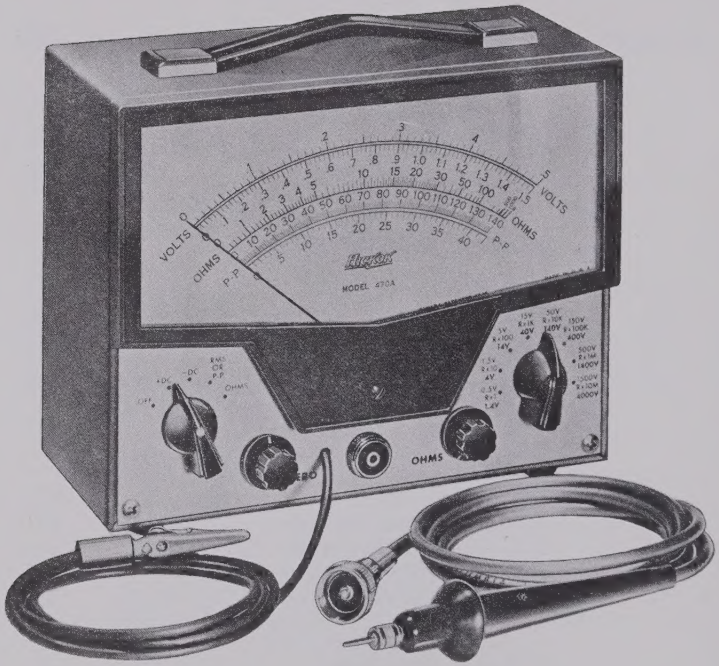


Figure 1-1. Model 470A "Uni-Scale" Vacuum Tube Voltmeter

SECTION 1

GENERAL INFORMATION

1-1 Purpose

The Model 470A "Uni-scale" Vacuum Tube Voltmeter, illustrated in Figure 1-1, is designed to accurately measure a wide range of AC and DC voltage and resistance. It can be used to measure AC or DC voltages from 10 millivolts to 1500 volts, and resistances from 0.2 ohms to 10,000 megohms. Simplicity in readability is achieved by reducing the basic scales to "FIVE". AC and DC values are read from the same scales; AC errors due to crowding on low ranges are eliminated.

The Model 470A is supplied with a single detachable probe which is used on all functions. The switch position on the probe marked "ACΩ" is a "straight thru" position used in measuring AC voltage and resistances, the other position, marked "DC", inserts a one megohm isolation resistor in the circuit for DC voltage measurements. See Figure 1-5 (back of manual) for a schematic diagram of this instrument.

1-2 Technical Data Reference

1. Operating Power Required: 105-125v, 60 cps, 10 watts.

2. Scales:
   a. VOLTS - 0-0.5, 0-1.5
   b. OHMS - 0-infinity, center scale value 10
   c. P-P - 0-40, 0-140

3. Ranges:
   a. DC or AC Volts - 0-0.5, 1.5, 5, 15, 50, 150, 500, 1500
   b. OHMS - RX1, X10, X100, X1K, X10K, X100K, X1M, X10M. Center scale readings of 10 ohms to 100 megohms.
   c. P-P VOLTS - 0-1.4, 0-4, 14, 40, 140, 400, 1400, 4000

4. Frequency Response: AC RMS or Peak-to-Peak - approximately 3 mc.

5. Input Impedance: a. DC Volts - 17.7 megohms
b. AC Volts - 17.7 meg/150 pf

6. Meter: Hickok Model S22K, Special - Sensitivity; 100 microamperes, 2K ± 5%

EQUIPMENT SUPPLIED (One Complete Unit)

Qty per Equip.	Nomenclature	Stock No.	Dimensions (Inches)
1	Vacuum Tube Voltmeter	902-367	7-1/2 x 6-3/8 x 1/4
1	Instruction Book	2490-412	5 x 7
1	Probe Assembly	16970-56	48

1-3 Functional Description

a. Physical: The instrument is enclosed and protected in a metal case. A vinyl carrying strap is provided for transportation and handling ease. The chassis mounted in the case, is easily accessible by removing two (2) screws located in the rear of the case and two (2) screws in the lower corners of the front panel. The scales on the dial are clearly marked and the meter is accurately calibrated at the factory. A mechanical adjustment is provided on the front of the meter for zero setting.

b. Function: The Model 470A is designed to perform the following electrical functions:

1. Measurements of a wide range of ac and dc voltages and resistances.
2. Provide a very light loading effect on the circuit under test, thereby insuring greater accuracy.
3. A meter circuit design, which will minimize the possibilities of damage to the meter due to overload.

NOTE

Due to the high impedance of the Model 470A, it is recommended that the "ZERO" adjustment of the meter be made with the "INPUT" probe shunted to "GND".

c. Electrical: An external AC power source of 105 to 125 volts, at a line frequency of 60 cycles is required for the operation of the Model 470A power supply system. A 1.5 volt "C" battery supplies the necessary dc voltage for making resistance measurements.

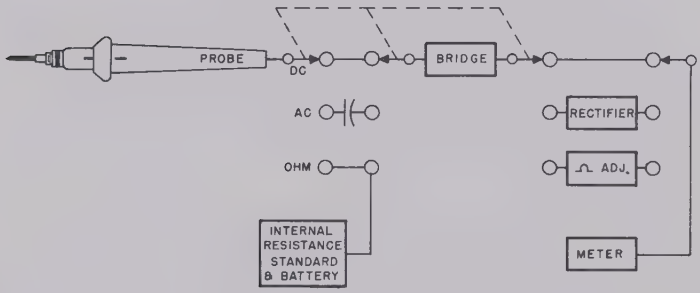


Figure 1-2. Block Diagram of Model 470A

NOTES

SECTION 2

CIRCUIT DESCRIPTION

2-1 General

A thorough understanding of the theory behind this instrument will enable the user to obtain greater utility and satisfaction from the instrument. Following is a brief explanation of the Model 470A circuit.

2-2 Bridge Circuit

a. The bridge circuit in the Model 470A is common to all measuring circuits and is similar in operation to the well-known Wheatstone bridge.

b. B+ voltage is applied across the bridge at R18. This resistor (R18) is adjusted so that with zero voltage input to the active grid of V1, the two triode sections of the twin triode are balanced and the meter indicates zero. In all measurements, the grid of one triode remains at ground potential. Changing the potential of the active grid will unbalance the bridge and cause a deflection of the meter in direct proportion to the change in grid potential. The Model 470A has a calibrated scale on which deflection is read in terms of volts or ohms, so that by properly setting the "RANGE" switch, the unknown measurement can be evaluated directly from the scale reading.

2-3 AC Voltmeter

The unknown ac voltage is measured with the probe switch in the "AC-OHM" position. This voltage is then rectified. The instrument is accurately calibrated in terms of the rms and peak-to-peak value of the ac voltage being measured.

2-4 DC Voltmeter

With the probe switch set to the "DC" position and the "FUNCTION SELECTOR" switch set to the "+DC" or "-DC" position, the meter pointer should indicate zero. The dc voltage being measured is attenuated and applied to the grid of V1 and therefore causes the meter pointer to deflect indicating the magnitude of the

unknown voltage. With the "FUNCTION SELECTOR" switch set to "+DC", advancing the "ZERO ADJ." control will bring the meter pointer to center scale providing a zero center dc voltage scale.

2-5 Ohmmeter

When an unknown resistance is connected between the "INPUT" probe and the common test lead, it is placed in series with a known resistance and a dc voltage. The value of this known resistance is determined by the position of the "RANGE SELECTOR" switch. The voltage applied to the input grid of the bridge tube is the voltage drop across the unknown resistance. This produces a meter deflection which is calibrated in terms of resistance.

SECTION 3

OPERATION INSTRUCTIONS

WARNING

THE HIGH VOLTAGES WHICH CAN BE MEASURED WITH THIS INSTRUMENT MAY BE DANGEROUS TO LIFE. EXTREME CARE SHOULD BE TAKEN TO AVOID BODILY CONTACT WITH EXPOSED HIGH VOLTAGES.

3-1 General

a. When making resistance measurements be sure that the circuitry under test has been de-energized.

b. Avoid errors in resistance measurements by making sure that the unknown resistance is isolated from other circuits; this can be done by freeing one lead of the component under test.

c. Allow a fifteen minute warm-up period so that stable operation of the instrument is assured. Keep the instrument turned on to avoid delay, if it is determined that it will be used intermittently over a period of time.

3-2 AC Voltage Measurements

a. Connect the input probe assembly to the panel connector marked "INPUT".

b. Set the rotary switch on the probe to the "AC-OHM" position.

c. Set the "FUNCTION SELECTOR" switch to the "AC" voltage position.

NOTE

If the approximate magnitude of the voltage to be measured is known, turn the "RANGE SELECTOR" switch to the corresponding

NOTE (Cont)

range. If the magnitude of the voltage to be measured is unknown, set the "RANGE SELECTOR" switch to the highest AC range and when the voltage is actually being measured turn the "RANGE SELECTOR" switch to a range on which the meter deflection is in the upper portion of the scale.

d. Adjust the "ZERO ADJ." control until the meter indicates zero. Meter will read upscale either side of correct setting.

e. Connect the permanently attached common lead to the circuit ground.

f. Touch the probe to the other side of the voltage source and read this voltage on the corresponding scale.

g. RMS or peak-to-peak values of the voltage being measured can be determined by reading the correct scales. (Measurement is made with an average reading detector.)

h. AC Frequency Characteristics: The input capacity of the ac measuring circuit is approximately 150 μμfd using the input probe. Voltage measurements of frequencies up to 3 megacycles can be expected to be accurate.

NOTE

If the rotary switch on the probe were accidently turned on the "DC" position, the instrument would still read volts but the readings would be approximately 10% low.

3-3 DC Voltage Measurements

a. Set the "FUNCTION SELECTOR" switch to the proper "DC" voltage position.

b. Set the "RANGE SELECTOR" switch to the appropriate position.

c. Adjust the "ZERO ADJ." control so that the meter indi-

cates zero.

d. Connect the unshielded black test lead to the circuit ground.

e. Set the rotary switch on the probe to the "DC" position.

f. Connect the tip of the probe to the other side of the dc voltage to be measured and read the dc voltage directly from the volt scale.

NOTE

If the "RANGE SELECTOR" switch is on the 1.5, 15, 150 or 1500 volt position, read the 0 to 1.5 scale and multiply by the correct factor. If the 0.5, 5, 50 or 500 volt range is being used, read the 0 to 0.5 scale and multiply by the correct factor.

3-4 Resistance Measurements

a. Set the "FUNCTION SELECTOR" switch to the "OHMS" position.

b. Operate the "RANGE SELECTOR" switch, giving consideration to the value of the resistance to be measured.

c. Set the rotary switch on the probe to the "OHMS-AC" position.

d. Short the ground lead to the input of the probe and adjust the "ZERO ADJ." control for zero on the ohms scale.

e. With the two test leads open adjust the "OHMS ADJ." control for a reading of full scale or infinity on the ohm scale.

f. Connect the test leads across the unknown resistance and read the numerical value on the ohms scale. Apply the proper multiplication factor (determined by the position of the "RANGE SELECTOR" switch).

3-5 Low Voltage Measurements

Due to the high sensitivity of the 0.5 volt range a slight amount of pick-up may be present. It is suggested, therefore, that the input of the probe be shorted to the ground lead so that an accurate "Zero Adjustment" can be made.

SECTION 4

MAINTENANCE

4-1 General

The Model 470A has been built to high working standards and therefore no maintenance other than routine replacement of the tube or battery should be necessary. Should the instrument need maintenance other than routine replacements, it is suggested that the factory be notified with regard to the nature of the trouble, and if necessary, ship the instrument to the factory or an authorized Hickok service station for inspection and service.

NOTE

Figure 1-4 which indicates component location, and the schematic wiring diagram, Figure 1-5, are presented as an aid in maintaining the instrument.

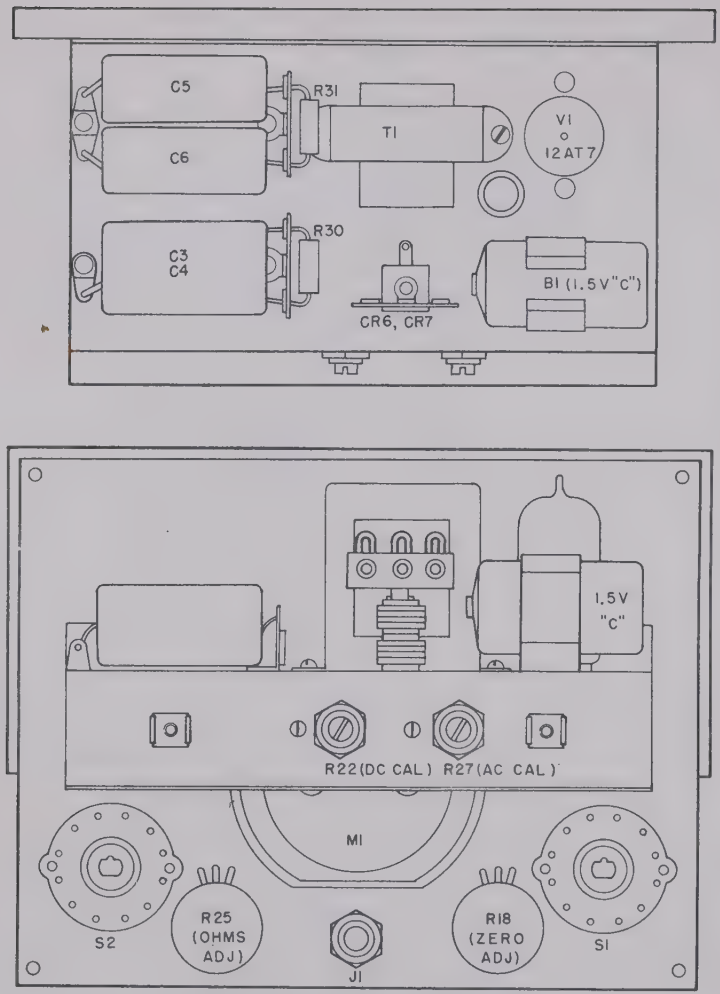


Figure 1-4. Component Location

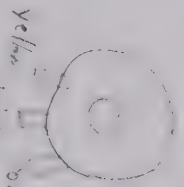
Cal. A/C VOLTAGE FIRST

SECTION 5

PARTS LIST

5-1 General

Reference designations are assigned to identify all parts for the Model 470A. These are used in the parts list and schematic wiring diagram. The letter prefix of a reference designation indicates the kind of part -- resistor, capacitor, electron tube, etc. The number differentiates between parts in the same group.



NOTE

A minimum billing charge of $3.50 will be assessed for any parts order. Prices are subject to change without notice.

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
B1		BATTERY: unitcell, size C, 1-1/2v	2210-1	.25
C1		CAPACITOR, FIXED, CERAMIC: .015 μf, (+80 -20%) 1600 vdcw, disc type	3310-154	.25
C2		CAPACITOR, FIXED, ELECTROLYTIC: 50 μf, 3v	3085-151	.75
C3		CAPACITOR, FIXED, ELECTROLYTIC: 20-20μf, 250v	3085-152	1.10
C4		Same as C3		
C5		CAPACITOR, FIXED, ELECTROLYTIC: 20 μf, 250v	3085-74	.80
C6		Same as C5		
C7		CAPACITOR, VARIABLE: 35-55 μμf, 1200 vdc test	3115-37	.80
C8		CAPACITOR, FIXED, MICA: 75 μμf, 5%, 500v	3095-167	.25
C9		CAPACITOR, FIXED, MICA: 430 μμf, 5%, 500v	3095-168	.35
C10		CAPACITOR, FIXED, CERAMIC: 1500 μμf, 10%, 600v	3110-155	.25

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
C11		CAPACITOR, FIXED, MYLAR: .005 μf, 10% 600v	3090-9	.15
C12		CAPACITOR, FIXED, MYLAR: .015 μf, 10%, 400v	3090-10	.15
C13		CAPACITOR, FIXED, MYLAR: .05 μf, 10%, 200v	3090-11	.15
C14		CAPACITOR, FIXED, MYLAR: .15 μf, 10%, 200v	3090-12	.20
CR1		CRYSTAL: diode	3870-78	.80
CR2		Same as CR1		
CR3		Same as CR1		
CR4		Same as CR1		
CR5		Same as CR1		
CR6		RECTIFIER: selenium	18150-18	.90
CR7		Same as CR6		
J1		CONNECTOR	3475-29	.40
P1		CONNECTOR: microphone	3475-3	.30

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
R1		RESISTOR, FIXED, COMPOSITION: 2.7 megohms, 5%, 1/2 watt	18415-271	.25
R2		RESISTOR, FIXED, FILM: 10 megohms, 1%, 1 watt	18561-11	.95
R3		RESISTOR, FIXED, FILM: 3.5 megohms, 1%, 1/2 watt	18560-37	.55
R4		RESISTOR, FIXED, FILM: 1 megohm, 1%, 1/2 watt	18560-29	.55
R5		RESISTOR, FIXED, FILM: 350K ohms, 1%, $\frac{1}{2}$ watt	18560-31	.55
R6		RESISTOR, FIXED, FILM: 100K ohms, 1%, $\frac{1}{2}$ watt	18560-22	.55
R7		RESISTOR, FIXED, FILM: 35,000 ohms, 1%, $\frac{1}{2}$ watt	18560-21	.55
R8		RESISTOR, FIXED, FILM: 10,000 ohms, 1%, $\frac{1}{2}$ watt	18560-26	.55
R9		RESISTOR, FIXED, FILM: 5,000 ohms, 1%, $\frac{1}{2}$ watt	18560-30	.55
R10		RESISTOR, FIXED, FILM: 9.75 ohms, 1%, $\frac{1}{2}$ watt	18560-28	.65
R11		RESISTOR, FIXED, FILM: 90 ohms, 1%, $\frac{1}{2}$ watt	18560-25	.65

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
R12		RESISTOR, FIXED, FILM: 900 ohms, 1%, $\frac{1}{2}$ watt	18560-20	.55
R13		RESISTOR, FIXED, FILM: 9,000 ohms, 1%, $\frac{1}{2}$ watt	18560-24	.55
R14		RESISTOR, FIXED, FILM: 90,000 ohms, 1%, $\frac{1}{2}$ watt	18560-23	.55
R15		RESISTOR, FIXED, FILM: 900K ohms, 1%, $\frac{1}{2}$ watt	18560-27	.55
R16		RESISTOR, FIXED, FILM: 9 megohms, 1%, 1 watt	18561-10	.95
R17		RESISTOR, FIXED, FILM: 90 megohms, 1%, 2 watt	18562-10	2.50
R18		POTENTIOMETER: composition, 1,000 ohms, 20%, 1 watt, linear taper	16925-416	1.95
R19		RESISTOR, FIXED, COMPOSITION: 15K ohms, 5%, 2 watt	18433-151	.50
R20		Same as R19		
R21		RESISTOR, FIXED, COMPOSITION: 1,000 ohms, 5%, 1/2 watt	18412-101	.25
R22		POTENTIOMETER: composition, 2,500 ohms, 30%, 1/2 watt, linear taper	16925-414	1.95

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
R23		RESISTOR, FIXED, COMPOSITION: 5,600 ohms, 10%, 1/2 watt	18412-562	.12
R24		RESISTOR, FIXED, COMPOSITION: 3,300 ohms, 10%, 1/2 watt	18412-332	.12
R25		POTENTIOMETER: composition, 250 ohms, 30%, 1/2 watt, linear taper	16925-413	1.95
R26		RESISTOR, FIXED, COMPOSITION: 470 ohms, 10%, 1/2 watt	18411-472	.12
R27		POTENTIOMETER: composition, 5,000 ohms, 30%, 1/2 watt, linear taper	16925-415	1.95
R28		RESISTOR, FIXED, COMPOSITION: 82K ohms, 5%, 2 watt	18433-821	.50
R29		Same as R28		
R30		RESISTOR, FIXED, COMPOSITION: 2,200 ohms, 10%, 1 watt	18422-222	.20
R31		Same as R30		
S1		SWITCH, ROTARY: 4 section, 5 position	19912-487	4.95
S2		SWITCH, ROTARY: 3 section, 8 position	19912-488	3.75

Ref. Desig.	Notes	Name and Description	Hickok Part No.	Price Each
T1		TRANSFORMER: power	20800-265	3.50
V1		TUBE: 12AT7	20875-77	3.05
XV1		SOCKET: 9 pin	19350-194	.45
		MISCELLANEOUS PARTS		
		BOOK, INSTRUCTION	2490-412	1.00
		METER	220-181	20.35
		PROBE ASSEMBLY	16970-56	8.50 1200